OLEVEL

BIOLOGY - 5090

PLANT NUTRITION

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NOTES

Photosynthesis

Plants are autotrophs, meaning that they produce their food. Photosynthesis is the foundational process through which carbohydrates are created by plants from raw materials using energy from sunlight.

$$6CO2 + 6H20 + (energy) \rightarrow C6H12O6 + 6O2$$

Investigations

Preparing a leaf for the starch test

1. Boil the leaf in water. This not only denatures the enzymes that would convert starch into its products but also makes the cell membrane more permeable. The leaf will become soft.

2. Now, boil the leaf in ethanol which is a solvent for chlorophyll. Use a water bath for this step to ensure uniform heating and safety. This removes the green pigment, making the color change visible. The leaf will now become hard and brittle.

3. Rinse the leaf in water to make it soft and permeable.

4. Place it on a white tile for clear results.

5. Add iodine solution to test for the presence of starch. As skin contact with iodine solution can have side effects, make sure to be careful.

Result:

1. Destarch a plant by keeping it in darkness for a few hours. Then, check the leaf for the starch test.

2. Cut a shape from a piece of black paper, and stick it to a destarched leaf.

3. Place the plant in daylight for a few hours.

4. Remove the leaf, and test it for the presence of starch.

Result:

Only areas exposed to light will turn blue-black in iodine solution.

The Necessity of Carbon Dioxide

1. Destarch 2 potted plants by keeping them in darkness for a few hours. This will ensure that all starch converts back to glucose to be respired, and we can start the experiment from the beginning.

2. Cover one of the plants with a polythene bag (investigation) to avoid carbon dioxide entry.

3. Put a dish with soda-lime to absorb all carbon dioxide from soil and air.

4. Keep both of these plants in sunlight to photosynthesize.

5. Pluck one leaf from each plant.

6. Prepare both leaves for a starch test.

Result:

Since there was no carbon dioxide in the first plant, the iodine test will be negative. While for the second plant, the test is positive due to the presence of carbon dioxide.

The point of control experiment is to compare and contrast with the investigation by providing all limiting factors.

The Necessity of Chlorophyll

1. Take a plant with variegated leaf i.e. a leaf with chloroplast in patches.

2. Destarch the plant by keeping it in darkness for a few hours. Then, keep it in daylight for a few hours.

3. Take a variegated leaf, and prepare it for a starch test.

Result:

Factors Affecting the Rate of Photosynthesis

Light intensity

A plant cannot photosynthesize without enough light, even if there is enough water and carbon dioxide.

1. Take a plant, and destarch it.

2. Take an aquatic plant e.g. seaweed, and place it in a beaker.

3. Place two wooden blocks in the beaker, and then put a filter funnel in, and cover it with a test tube.

4. Place a lamp far from the beaker, and you will observe that the rate of bubbles is slow.

5. Bring the lamp closer to the beaker. After a few minutes, you will observe that bubbles will appear steadily.

6. Repeat several times at different distances.

Result:

Increasing light intensity increases the speed of the reaction. As light energy increases, the energy absorbed by the chlorophyll.

Temperature

At low temperatures, the enzymes do not have the energy to meet many substrate molecules, so the rate of reaction decreases. At the optimum temperature, enzymes are the most efficient. On further increase in temperature, the enzyme denatures and cannot be used again.

Carbon Dioxide Concentration

Carbon dioxide is used to make sugar in plants. An increase in carbon dioxide concentration causes the rate of reaction to increase. This is possible in greenhouses. In glasshouses, carbon dioxide concentration can be controlled. In the air, its concentration is low but it is possible to provide extra carbon dioxide for plants in a glasshouse.

· Limiting factor is present in the environment in such short supply that it restricts life processes.

Leaf Structure

A leaf is attached to the stem through a leaf stalk, which continues into the leaf as midrib. There is a network of veins that deliver water and salts to the leaf cells. The leaf lamina is the broad surface of the leaf.

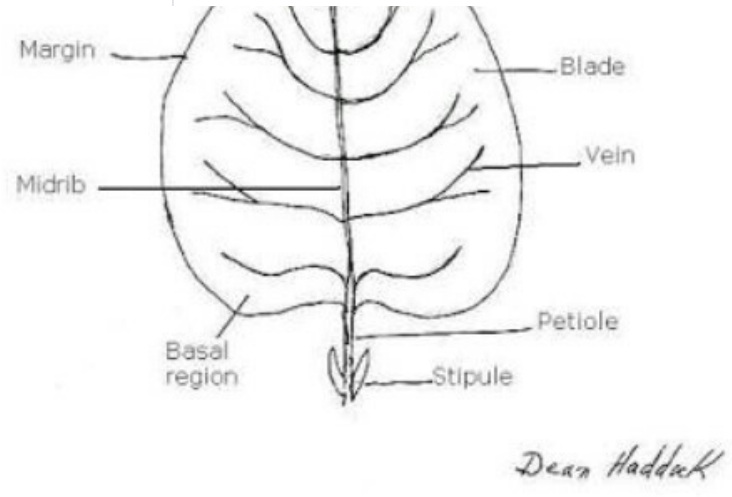

Figure (i) Leaf Structure, Credit: Brainly.in

Internal Structure

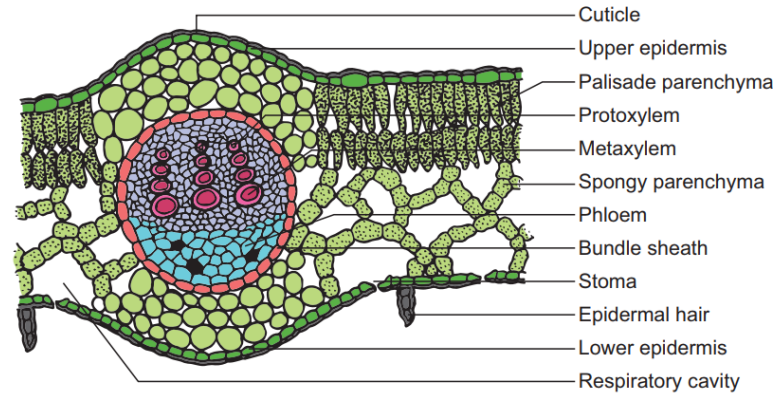

Figure (ii) Cell Structure of a Dicot Leaf, Credit: Brainkart

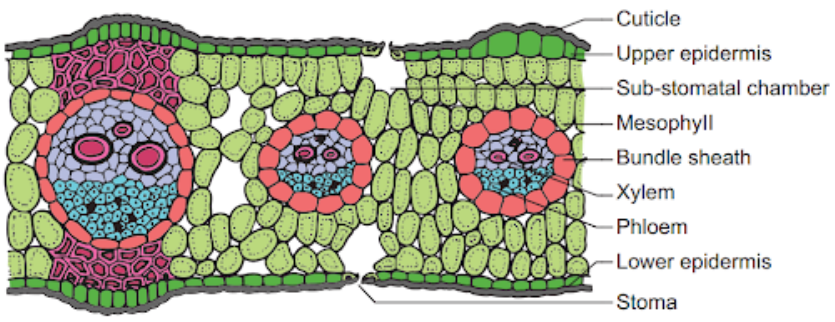

Figure (ii) Cell Structure of a Monocot Leaf, Credit: Brainkart

Cuticle

The cuticle is a waxy, waterproof substance secreted by the upper epidermis cells. It prevents water loss and provides moisture.

Epidermis

These are closely fitted cells present on the upper and lower layer of the leaf. Upper epidermis is thin and transparent to allow the free passage of light. They do not have any chloroplasts, and they also prevent the entry of disease-causing organisms e.g. bacteria, fungi. The lower epidermis acts as a protective layer. Stomata are present on the lower epidermis.

Mesophyll

The Mesophyll cell has two types: spongy mesophyll and palisade mesophyll cells. Palisade mesophyll cells are perpendicular to the upper epidermis. These are thin, tall and tightly packed. They are rich in chloroplasts, making themselves a photosynthesizing tissue. The dense packing of these cells allows the absorption of the maximum amount of light energy for the manufacture of food. The chloroplasts in them are present on the edge of the cell so more light energy can be absorbed. Spongy mesophyll cells are scattered.

The air spaces present between them aid the process of diffusion of gases through the leaf. The air spaces are saturated with water vapor, so water diffuses out of the leaf. During the day time, the rate of photosynthesis is high. Thus, the concentration of carbon dioxide decreases in the air spaces, and carbon dioxide diffuses in through the stomata. Oxygen is produced as a by-product, so when its concentration

In between the lower epidermis cells, there are small openings known as Stomata. They are open during the daylight but are closed during the night time. When they are open, carbon dioxide gas diffuses into the leaf. When stomata close, carbon dioxide stops diffusing in, and the process of photosynthesis stops. Guard cells are surrounding the stomata, and they regulate the stomata by opening and closing them. They aid gaseous exchange and help in preventing water loss by transpiration.

Vascular Bundles

The transport systems of the cells are vascular bundles (veins). The xylem vessels transport water and mineral salts in and out of the cell. The phloem tissue transports organic products of photosynthesis i.e. glucose. Bundle sheath cells form a protective covering around the vascular bundle.

Mineral Nutrition

- Nitrate ions are required for making amino acids for proteins. They are also needed for DNA and nucleic acid. Nitrate ions are needed for the growth, repair and cell division. Deficiency of nitrate ions causes stunted growth of plants and leaves, and this will further stop photosynthesis.

- Magnesium ions are required for the production of chlorophyll, the green pigment which absorbs light for photosynthesis. The deficiency of magnesium ions causes yellow leaves. It also causes a decrease in glucose.